

the close of their studies with certificates testifying to their diligence and their acquirements.

All this instruction is absolutely gratuitous. M. Fremy wishes to remain faithful to the old motto of the museum, "Tout est gratuit dans l'établissement," though this excessive liberality is perhaps open to criticism.

Behind the magnificent chemical rooms we found the modest laboratory of M. Decaisne. Descending a few steps we reach a garden set apart to experiments in culture, having on the left a glazed gallery: this is the laboratory of vegetable anatomy and physiology. M. Decaisne superintends and advises the anatomists during his daily visits; M. Dehérain, who is well known for his researches in agricultural chemistry and vegetable physiology, directs the work of the laboratory represented in our illustration. It is a long apartment, perfectly lighted, into which stream the rays of the sun, that plays so important a part in all the phenomena of vegetable life; on the right, ventilators carry off all the strong-smelling gases which the chemist is obliged to employ; long tables, furnished with earthenware vessels, extend along the middle of the apartments as well as underneath the windows. Everything is scrupulously tidy.

This laboratory of agricultural chemistry will no doubt yield to agricultural chemistry important results. The man of science will have here the means of preparing at pleasure true artificial soils; he will see plants of various kinds grow under his eyes; he will nourish them with organic and mineral substances whose composition is known to him. He will follow step by step the various phases of vegetable life; he will study the yet mysterious laws of vegetable life. Indeed it is difficult to state all the powerful resources that are in the hands of the experimenter.

AËRIAL SPECTRES

IN an article on the above subject in *La Nature*, No. 4, M. G. Tissandier gives the following account of what he saw from a balloon on February 16, last.

At mid-day we quitted the earth wrapped in a thick mantle of fog; after traversing the mass of the clouds, we were suddenly dazzled by torrents of light which shot

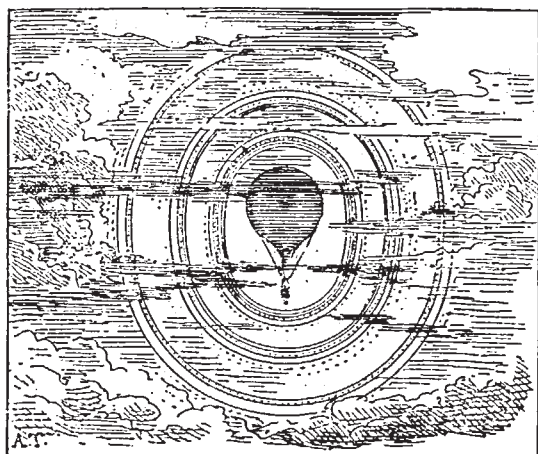


FIG. 1.—Shadow of a balloon surrounded by three aureoles.

from a tropical sun, a stream of fire, in the midst of an azure sky. Neither the *mer de glace* nor the snowy fields of the Alps, give an idea of the plateau of mist which stretched under the car like a glassy circle, in which valleys of silver appeared in the midst of flakes of gold. Neither the sea at sunset nor the ocean waves when lighted up by the orb of day at noon, approach in splendour this array of circular cumulus, but which

have, in addition, "the light that never was on sea or land."

When our balloon had passed about 50 metres beyond the plain of clouds, its shadow was projected with remarkable precision, and a magnificent circular rainbow appeared round the shadow of the car. Fig. 2 gives a very exact idea of the phenomenon. The shadow of the car formed the centre of rainbow-coloured concentric circles, in which were distinctly seen the seven colours of the spectrum, violet, indigo, blue, green, yellow, orange, and red. The violet was inside, and the red on the outside, these two colours being at the same time those which were seen with the greatest distinctness. We were,

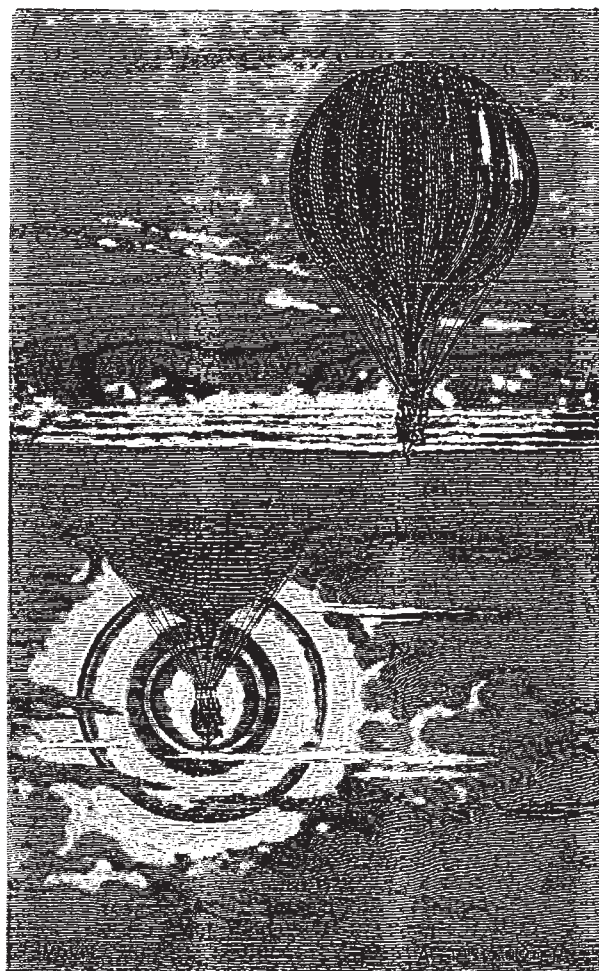


FIG. 2.—Optical phenomenon observed from a balloon.

at the time the observation was made, at a height of 1,350 metres above the level of the sea.

The balloon, the gas in which expanded under the heat of the sun, continued to rise rapidly in the air, its shadow visibly diminishing; soon, at a height of 1,700 metres, the rainbow-circle enveloped it entirely, and disappeared from around the car. A little later, at about 1^h 35^m, we approached the bed of clouds, and the shadow was girt this time by three silver-coloured aureoles, elliptical and concentric, as shown in Fig. 1.

Nothing can give an idea of the purity of these shadows, which are cut out in an opaline mist, or of the delicacy of tone of the rainbow which surrounds them. The complete silence which reigns in the aerial regions, where this play of light is seen, the absolute calm which

exists there, above clouds transformed by the sun into flakes of light, adds to the beauty of the spectacle, and fills the soul with inexpressible admiration.

We do not yet know exactly to what cause to attribute the production of a luminous contour around the shadow projected upon vapours or mists. Some observers have thought that these phenomena are due to the diffraction of light, but it is possible that they have a common origin with the rainbow. What tends to confirm this opinion is the necessity for the presence of the vapour of water as a necessary condition of the phenomenon: if it is the result of diffraction, it ought to appear as well upon a white wall, or any kind of screen, as upon a cloud. It is possible, moreover, to study these curious phenomena by means of experiments upon the earth; by suitably arranging screens of silk or muslin saturated with water, which resemble a cloud, we may expect to be able to produce the phenomenon. M. Leterne points out another excellent method of studying it. On a spring morning, when the sun, about 15 or 20 degrees above the horizon, has warmed the atmosphere a little, and has produced a light condensation of vapour upon the grassy borders of the roads, one may see his silhouette projected upon the humid verdure, surrounded by a luminous contour, in which is seen the colours of the spectrum, the red, however, being strongest.*

THE GEOLOGICAL SURVEY OF INDIANA

GEOLOGY is a branch of Science which specially commends itself to the fostering care of Governments, paternal or otherwise. More particularly is this true of a new country, where, in the imagination of the settlers, untold wealth has yet to be dug out of the earth, if only they could discover in what quarter best to look for it. Accordingly, in not a few of our colonies and in a number of the States of the Union, geological and mineralogical surveys have long been at work, originated and continued at the public expense. In most cases, of course, the first aim of such surveys, and in fact the very justification of their existence in the eyes of practical and by no means scientific legislators, is the finding of mineral wealth. If they were begun from the lofty scientific point of view they would fail, and deservedly. But when a really able scientific man gets the charge of one of them, and has at the same time that mother-wit and knowledge of the world which scientific men so often lack, he may not only attend to the rigid economics of his paymasters, but do great service to geology. His aim is to show the public that a strictly scientific basis is the only one on which a mineral survey to be of any value can be conducted. And this is so obvious that if it is simply and clearly stated, it for the most part commends itself to the common-sense of public men. In laying this necessary basis and then in carrying out the survey for economic minerals the geologist may both pave the way for an enormous increase to his country's industry and wealth, and add much of permanent interest and importance to the common stock of geological knowledge.

Perhaps the most notable illustration of the successful accomplishment of this double mission is furnished by the career of Sir William Logan, whose practical kindly ways enabled him to triumph over the shortsightedness of colonial obstructionists, and whose patient and sagacious labours among the rocks of Canada have made his name honoured and familiar all over the world, and have conferred distinction also upon his country. In the United States, too, fostered by the liberality of the Legislatures, a number of admirable State surveys have been made, or are still in progress. Under the auspices of such men as James Hall, Owen, the Hitchcocks, the brothers Rogers, Hayden, Whitney, Blake, Cook, and others, not only have maps been constructed, but elaborate reports have

been published, embracing, in addition to the paramount economics, much valuable information in geology, mineralogy, and palæontology.

One of the latest of these State surveys is that of Indiana, which was started some four years ago under the direction of Prof E. T. Cox. Like those already referred to, it was organised by the authorities "for the purpose of collecting information designed to promote the interests of agriculture, arts, manufactures, and mining." But it was furnished at the same time with an analytical laboratory "for analysing such ores and substances as may be deemed useful to the State," and with space "to build up a geological and natural history cabinet," while in order to render its labours as speedily serviceable as possible, an annual report of progress was required to be issued.

Prof. Cox has evidently a hard task before him. He has been invited to become a kind of depository of all the mining information in the State. He is to see that trustworthy mineral surveys are made, and at the same time he is expected to look after the laboratory and infant museum at Indianapolis and—perhaps most laborious but not least useful of all—to receive everybody who wants to know about coal, iron, or other mineral produce, and to collect and furnish to such inquirers all the information procurable. He generously says in one of his reports that this latter part of his duties "has always given him pleasure," though he confesses that it has consumed a considerable portion of his time. Fortunately he can count on the help of a small but apparently able staff of assistants, and notwithstanding all the obstacles in his way he has succeeded in getting through a large amount of work which, though not yet of high scientific value, must bear most importantly upon the future development of Indiana.

Three volumes of reports with maps have been published, bringing the account of the progress of the Survey up to the end of last year. Each of these neatly printed and not too bulky octavos describes several counties of the State with reference chiefly to the distribution of economic minerals; and the maps which accompany it, though roughly and cheaply executed, are clear and must be of infinite service to the many speculators and others who every year come in increasing numbers into the state in search of mineral investments. The coal-field of Indiana, though only a part of the larger basin of Illinois, is estimated to equal more than half of the area of the whole of the coal-fields of Great Britain and Ireland. Some of the coal-seams are of excellent quality, specially that known locally as "block-coal," which is said to be unrivalled for iron-furnaces. Abundant iron ore likewise occurs. Hence not only coal-pits but iron-works are springing up in rapidly increasing numbers. Not a little of this wonderful rapidity of growth is attributed by Prof. Cox, and no doubt justly, to the extended and more accurate knowledge of the minerals which the Survey has been able to publish. In the course of two or three years tracts of "primeval forest" have vanished, and in their place the visitor would now see clanking engines and mining villages, crowded with a population as busy and begrimed as any to be met with in Staffordshire or Lanarkshire. And yet vast though this change is, it may be said to have only just begun. Before many years are over the coal-bearing part of the formerly quiet agricultural state of Indiana will become one of the most active centres of industry in the Union, with railways diverging in all directions to carry away its mineral produce.

Prof. Cox and his assistants have not only been successful in pointing out the mineral resources of the various counties. In looking through his reports one can see that he continues from year to year to slip in more of general scientific interest. This is notably the case with the volume lately published. In addition to a series of

* *Comptes Rendus*, t. lxxvi. p. 786.